

CLAIMS

What is claimed is:

- 1 1. A magnetic head having an air bearing surface (ABS), comprising:
2 a free layer structure, comprising:
3 a first free layer having a magnetic moment;
4 a second free layer having a magnetic moment pinned antiparallel to the
5 magnetic moment of the first free layer; and
6 a third free layer having a magnetic moment oriented parallel to the
7 magnetic moment of the second free layer;
8 wherein ends of the third free layer define track edges of the third free layer;
9 wherein the first and second free layers extend beyond the track edges in a
10 direction parallel to the ABS.
- 1 2. A head as recited in claim 1, wherein a net magnetic moment of the first and
2 second free layers is about zero.
- 1 3. A head as recited in claim 1, wherein the first and second free layers extend
2 beyond the track edges for distances each at least as long as a length of the third
3 free layer measured between the track edges thereof.

1 4. A head as recited in claim 3, wherein the first and second free layers extend
2 beyond the track edges for distances each at least five times as long as a length of
3 the third free layer.

1 5. A head as recited in claim 1, wherein a thickness of the first free layer is less than
2 a combined thickness of the second and third free layers, the thicknesses being
3 measured in a direction perpendicular to a plane of the first free layer.

1 6. A head as recited in claim 1, wherein a thickness of the third free layer is greater
2 than thicknesses of the first and second free layers individually, the thicknesses
3 being measured in a direction perpendicular to a plane of the first free layer.

1 7. A head as recited in claim 1, further comprising at least one antiferromagnetic
2 (AFM) layer positioned outside the track edges of the third free layer in a
3 direction parallel to the ABS, each AFM layer being for pinning a magnetic
4 orientation of portions of the free layer closest thereto and positioned outside the
5 track edges of the third layer.

1 8. A head as recited in claim 1, further comprising an antiparallel (AP) pinned layer
2 structure having at least two pinned layers having magnetic moments that are self-
3 pinned antiparallel to each other.

- 1 9. A head as recited in claim 1, further comprising a shield layer positioned above
2 the free layer structure, portions of the shield layer positioned outside the track
3 edges extending downwardly towards the portions of the free layer structure
4 positioned outside the track edges.
- 1 10. A head as recited in claim 1, wherein the head forms part of a CPP GMR sensor.
- 1 11. A head as recited in claim 1, wherein the head forms part of a CIP GMR sensor.
- 1 12. A head as recited in claim 1, wherein the head forms part of a tunnel valve sensor.
- 1 13. A magnetic head having an air bearing surface (ABS), comprising:
2 an antiparallel (AP) pinned layer structure having at least two pinned layers with
3 magnetic moments that are self-pinned antiparallel to each other, the
4 pinned layers being separated by an AP coupling layer; and
5 a free layer structure spaced apart from the AP pinned layer structure, the free
6 layer structure comprising:
7 a first free layer having a magnetic moment;
8 a second free layer having a magnetic moment pinned antiparallel to the
9 magnetic moment of the first free layer; and
10 a third free layer having a magnetic moment oriented parallel to the
11 magnetic moment of the second free layer;
12 wherein ends of the third free layer define track edges of the third free layer;

13 wherein the first and second free layers extend beyond the track edges in a
14 direction parallel to the ABS for distances each at least as long as a length
15 of the third free layer measured between the track edges thereof;
16 wherein a thickness of the first free layer is less than a combined thickness of the
17 second and third free layers, the thicknesses being measured in a direction
18 perpendicular to a plane of the first free layer.

1 14. A head as recited in claim 13, wherein a net magnetic moment of the first and
2 second free layers is about zero.

1 15. A head as recited in claim 13, wherein the first and second free layers extend
2 beyond the track edges for distances each at least five times as long as a length of
3 the third free layer.

1 16. A head as recited in claim 13, wherein a thickness of the third free layer is greater
2 than thicknesses of the first and second free layers individually, the thicknesses
3 being measured in a direction perpendicular to a plane of the first free layer.

1 17. A head as recited in claim 13, further comprising at least one antiferromagnetic
2 (AFM) layer positioned outside the track edges of the third free layer in a
3 direction parallel to the ABS, each AFM layer being for pinning a magnetic
4 orientation of portions of the free layer closest thereto and positioned outside the
5 track edges of the third layer.

- 1 18. A head as recited in claim 13, further comprising an antiparallel (AP) pinned layer
2 structure having at least two pinned layers having magnetic moments that are self-
3 pinned antiparallel to each other.
- 1 19. A head as recited in claim 13, further comprising a shield layer positioned above
2 the free layer structure, portions of the shield layer positioned outside the track
3 edges extending downwardly towards the portions of the free layer structure
4 positioned outside the track edges.
- 1 20. A head as recited in claim 13, wherein the head forms part of a CPP GMR sensor.
- 1 21. A head as recited in claim 13, wherein the head forms part of a CIP GMR sensor.
- 1 22. A head as recited in claim 13, wherein the head forms part of a tunnel valve
2 sensor.
- 1 23. A magnetic storage system, comprising:
2 magnetic media;
3 at least one head for reading from and writing to the magnetic media, each head
4 having:
5 a sensor having the structure recited in claim 1;
6 a write element coupled to the sensor;

- 7 a slider for supporting the head; and
- 8 a control unit coupled to the head for controlling operation of the head.